COMMONWEALTH OF AUSTRALIA

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Warning

CHARLES DARWIN UNIVERSITY

Family Name	
Given Names	
Student Number	
Teaching Period	Semester 2, 2015

FINAL EXAMINATION	**DURATION**
ENG481 – Applied Heat and Mass Transfer	Reading Time: **10** minutes Writing Time: **180** minutes

INSTRUCTIONS TO CANDIDATES

Section A: Suggested Time: 80 min	**Heat transfer**. Maximum number of marks for this section: 20 Answer all questions
Section B: Suggested Time: 60 min	**Mass transfer**. Maximum number of marks for this section: 10 Answer all questions
Section C: Suggested Time: 40 min	**Heating, Ventilating and Air Conditioning**. Maximum number of marks for this section: 10 Answer one of the two questions

EXAM CONDITIONS

This is a RESTRICTED OPEN BOOK examination

Any non-programmable calculator is permitted

No handwritten notes are permitted

Hard copy, unannotated English translation dictionary only

Answer on the supplied examination material/s only

ADDITIONAL AUTHORISED MATERIALS	EXAMINATION MATERIALS TO BE SUPPLIED
No additional printed material is permitted	1 x 16 Page Book Formula Sheet/s Reference Information

THIS EXAMINATION IS PRINTED DOUBLE-SIDED.

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Section A – Heat Transfer

Suggested Time: 80 mins

Maximum number of marks for this section: 20

Answer all questions

Question 1 **(10 Marks)**

A straight fin fabricated from 2024 aluminium alloy has a characteristic thickness of 3mm and a length of 15mm. The base temperature is 100^{o}C and the fin is exposed to a flow of atmospheric air at 20^{o}C and 10m/s. For these conditions, compare the fin heat transfer rate, efficiency, and volume for rectangular, triangular and cylindrical cross-sections. How does the heat rate per unit mass compare? Assume adiabatic tip.

Question 2 **(10 Marks)**

Spheres A and B are initially at 800K, and they are simultaneously quenched in large constant temperature baths, each having a temperature of 320K. The following parameters are associated with each of the spheres and their cooling processes:

	Sphere A	Sphere B
Diameter (mm)	300	30
Density (kg/m^3)	1600	400
Specific heat (kJ/(kg·K)	0.400	1.60
Thermal conductivity (W/(m·K)	170	1.70
Convection coefficient (W/m^2·K)	5	50

a) Show in a qualitative manner, on T versus t coordinates, the temperatures at the centre and at the surface for each sphere as a function of time. Briefly explain the reasoning by which you determine the behaviour and the relative positions of the curves.

b) Calculate the time required for the interface of each sphere to reach 415K.

c) Determine the energy that has been gained by each of the baths during the process of the spheres cooling to 415K.

Section B – Mass Diffusion

Suggested Time: 60 mins

Maximum number of marks for this section: 10

Answer all questions

Question 3 **(5 Marks)**

A minivan traveling 90km/hr has just passed through a thunderstorm that left a film of water 0.1mm thick on the top of the van. The top of the van can be assumed to be a flat plate 6m long. Assume isothermal conditions at 27^{o}C, an ambient air relative humidity of 80%, and turbulent flow over the entire surface. What location on the van top will be the last to dry? What is the water evaporation rate per unit area at the trailing edge of the van top?

Question 4 **(5 Marks)**

A large sheet of material 40mm thick contains dissolved hydrogen (H_2, 2g/mol) having a uniform concentration of 3kmol/m^3. The sheet is exposed to a fluid stream that causes the concentration of the dissolved hydrogen to be reduced suddenly to zero at both surfaces. This surface condition is maintained constant thereafter. If the mass diffusivity of hydrogen is $9 \cdot 10^{-7}$ m^2/s, how much time is required to bring the density of dissolved hydrogen to a value of 1.2kg/m^3 at the centre of the sheet?

Section C – Heating, Ventilating and Air Conditioning

Suggested Time: 40 mins

Maximum number of marks for this section: 10

Answer one question

Question 5 **(10 Marks)**

A room is to be maintained at 78^{o}F db and 65^{o}F wb. The total heat gain inside has been estimated to be 60,000Btu/hr, of which 42,000 Btu/hr is sensible heat. The outdoor air requirement is 500cfm. The outdoor air has temperature and relative humidity of 90^{o}F and 55% respectively. Determine the quantity and the state of the air supplied to the space and the required capacity of cooling and dehumidifying equipment. Present your answer in both Imperial and SI units.

Question 6 **(10 Marks)**

Using the equal friction method, select the duct sizes for the simple duct system shown in the figure below. Present your answer in both Imperial and SI units. The total pressure available for the duct system is 0.12 in. wg, and the loss in total pressure for each diffuser at the specified flow rate is 0.02 in. wg.

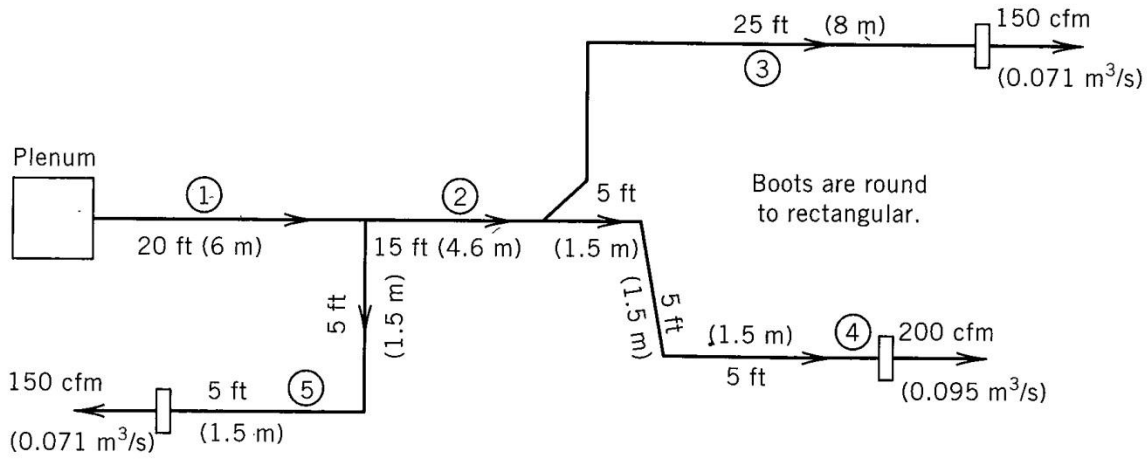

Figure 1 Schematic of a makeup and exhaust air system for Question 6